WHITE PINE COMMITTEE

MONTANA-NORTHERN IDAHO FOREST PEST ACTION COUNCIL

P.O. Box 600, Lewiston, Idaho

PROGRESS REPORT #4

Studies of Natural and Synthesized Attractants of the Mountain Pine Beetle

November 20, 1967

Review of Previous Efforts

Progress Report #3, dated January 16, 1967, summarized the project from the appointment of the Committee in February, 1965, through the year 1966. In brief: The White Pine Committee was appointed in February, 1965, to seek new and better methods of controlling the mountain pine beetle. The Committee was formed to fill a research gap caused by the deferment of the Intermountain Forest and Range Experiment Station's studies of the beetle problem in white pine.

The 1965 effort was a preliminary, gratis investigation of the problem by Drs. Pierre Vite' and Gary Pitman of the Boyce Thompson Institute for Plant Research. Dr. Pitman is director of Boyce Thompson's forest research center at Grass Valley, California. Dr. Vite' is Program Director in Forest Entomology for Boyce Thompson Institute at Yonkers, New York; he was formerly on the staff of Goettingen University in West Germany, and has pioneered much of the new beetle control research both in Europe and the United States.

On the basis of the 1965 studies, Potlatch Forests, Inc., contracted with Boyce Thompson in 1966 to make a more intensive study aimed at determining the practicability of a new approach to bark beetle control--utilizing the natural scent produced by the female beetle and its host tree as a lure to attract large numbers of the insect population to preselected, accessible locations where the pests could be easily destroyed through logging or with insecticides.

From June through August of 1966, a group of B.T.I. scientists conducted a series of studies and experiments in the vicinity of P.F.I.'s Headquarters operation. The group was under the direction of Dr. Pitman. Dr. Joachim Schonherr from West Germany's Freiburg University served as senior entomologist. He was assisted by his wife on laboratory phases of the project and by two technicians, one of whom was assigned from P.F.I.'s summer forestry crew. A World War II dairy building (since unused) was renovated to serve as a laboratory. A skid-mounted bunkhouse was moved adjacent to the lab and equipped to serve as a beetle rearing facility.

Limited studies were made on Ips montanus, as well as Dendroctonus ponderosae (mountain pine beetle), because I.m. is an important secondary insect frequently attacking white pine following the initial attack by D.p.

The 1966 studies were designed to:

1. Develop an effective field olfactometer for trapping beetles in order to study their flight habits and to bioassay the relative attractiveness of various candidate attractants (Fig. 1).

2. Determine the source of the best natural attractant. (Found to exist in boring dust and fecal pellets of females actively feeding in fresh phloem.)

3. Develop a technique for preparing attractive billets (log sections) for use in the olfactometers. (Beetles were collected from naturally infested trees, sexes were separated on the basis of stridulation (chirping sound) made only by males, and 50 females were inserted into nail holes in each billet and secured in place by covering the holes with one-inch squares of window screen.

4. Study the daily and seasonal flight habits of beetle populations (Fig. 2).

5. Measure oleoresin pressure of different vigor classes of white pines.

6. Develop a technique for attracting large numbers of the flying beetle population to specific, pre-selected locations. (One experimental attraction plot was established, some pines were weakened by girdling and spraying the bases with 2, 4, D-2, 4, 5, T, and the plot was "baited" by bringing in fresh, naturally-infested logs.

Results of the 1966 research (Table 1) were so encouraging that our committee recommended an expanded study with broader financial support. The Pest Action Council accepted the recommendation, and in 1967 two contracts were drawn with the Boyce Thompson Institute. One contract by Potlatch provides $15,000 support for a continuation of the Headquarters forest studies. The other contract is by the Idaho State Land Board to sponsor an attempt to duplicate the attractive compounds through chemical synthesis. This second contract is financed by $20,000 from a special forest pest abatement fund to which a large number of private forest landowners and operators contribute and which is administered by the State Land Board. Additional funds were provided by Boyce Thompson Institute, the Boyce Thompson Research Foundation, the Margaret T. Biddle Foundation, and the United States Public Health Service. The total money earmarked for this project in 1967 is approximately $112,000.

Boyce Thompson subcontracted with Battelle Memorial Institute in Columbus, Ohio, to assist in the identification and synthesis of the attractant compounds.

During the summer of 1967, a Boyce Thompson team again worked on field studies at P.F.I.'s Headquarters, under the direction of Dr. Pitman. The field study team was again led by Dr. Schonherr. The team included Larry French, a University of Idaho forestry student, and Miss Leanne Tippets of B.T.I.'s Grass Valley staff.

In addition to the field and laboratory work at Headquarters, Boyce Thompson also conducted intensive laboratory and chemical analysis work at its laboratories in Grass Valley, California, and Yonkers, New York, with most of the final chemical analysis and synthesis performed by the Battelle Institute.

The 1967 field and laboratory work have been summarized in a report by Dr. Pitman dated October 20, 1967. In brief, the results to date are as follows:

1. The best source of natural attractant was found to be the hindguts of female beetles feeding in fresh phloem. Hindguts from approximately 20,000 females were dissected under microscope (Fig. 4), packed in dry ice and shipped to the chemists for analysis.

2. The chemists isolated one major compound identified as trans-verbenol, a terpene alcohol. A quantity of trans-verbenol was synthesized from alpha pinene, diluted in petroleum ether and shipped to Headquarters and Grass Valley for field bioassay.

3. The Headquarters field olfactometer tests established the conclusion that trans-verbenol is a major component of the attractant materials responsible for mass aggregation of D.p. beetle populations. In five tests on separate days, when trans-verbenol was sprayed on a female-infested log section in one olfactometer, nearly twelve times more beetles were attracted than by an infested but unsprayed log in another olfactometer. However, when used alone the trans-verbenol did not attract any beetles; this strongly indicates that trans-verbenol is not the only compound involved in attraction.

4. Flight-behavior studies were continued in 1967 to further test the field olfactometers (Fig. 1) and to learn more about the daily and seasonal patterns of flight. These studies indicated a marked reduction in the flying population of D. ponderosae in 1967 as compared to 1966. Only 64% as many beetles (1,569) were trapped in 1967 as in 1966 (2,452), although the period of trapping in 1967 was 70 days longer (June 1 through September 26) than in 1966 (July 7 through August 23).

This conclusion was also supported by fewer peak-flight periods and fewer beetles during the peaks in 1967 as compared to 1966.

Only one flight peak of any significant numbers was observed in 1967 (June 15), whereas in 1966 there was one major flight in late spring with several lower peaks during the summer. Records of daily response patterns

(Fig. 2) also indicate a much higher population of flying beetles in 1966 than in 1967.

An independent survey made by P.F.I. foresters also indicated much fewer active 1967 brood trees than in earlier years, with the peak year indicated to be about 1964 or 1965. However, this survey was not sufficiently extensive to definitely establish a reliable beetle population trend. More such surveys are needed.

5. Two plots were installed in 1967 to further test methods of manipulating the flying beetle population and hopefully attracting large numbers to pre-selected locations. Only naturally-produced attractants were used because the synthesized trans-verbenol was not obtained until late in the summer.

Plot 1 (Fig. 3) was a 200' circular plot containing 55 white pines plus about one-third as many other species. Twenty-three of the pines were treated as "bait" trees in a manner similar to 1966 except that cacodylic acid was used on about one-half of the trees and 2,4,5,D-2,4,5, T on the balance. Also, naturally-infested logs were not brought in to create attraction; instead, manually-infested log sections were hung on the lower boles of some of the bait trees, while with others the female beetles were inserted directly into the tree bark. (The latter method generally proved to be more effective.)

Results of this attraction plot were encouraging, although not as many mass attacks were created as in the 1966 plot. This is attributed primarily to the lower population of flying beetles in 1967. Tables 1 and 2 summarize the 1966 and 1967 plot results.

In 1966, 32 or 71% of the 45 white pine trees on the plot sustained varying degrees of attack, while in 1967 only 28 pines or 51% were attacked. In 1966, 13 pines or 29% were mass attacked (over 100 beetles), while in 1967 only 5 pines or 9% were mass attacked. However, a comparison of only the treated trees is more encouraging; in 1966, 21 trees or 87% of the 24 treated trees were attacked; whereas in 1967, 22 trees or 96% of the 23 treated trees were attacked. Again, however, more of the treated trees were mass attacked in 1966 (7 trees or 29%) than in 1967 (3 trees or 13%).

These data have not yet been analyzed statistically, but they do indicate some encouraging trends. These plots were established to develop a workable plot design and technique. Many more plots must be established and analyzed before we can know with any certainty whether or not an effective method of manipulating beetle populations can be achieved. Also, we do not yet know whether or not the present, and hopefully future, synthetic materials will provide enough attraction to be effective in control programs. Certainly, an effective synthetic would greatly facilitate and reduce the cost of plot establishment.

A second plot, of different experimental design, was established in

1967 to study relationships between attractant trees, effective distance of attraction, and known brood sources. This is a complicated study and is described in G. Pitman's 10/20/67 report. In brief, the study indicates that baited trees closest to the source of the emerging brood were the most competitive in attracting beetles.

Summary

1. The fact has been established that flying mountain pine beetle populations can be attracted to and induced to mass attack pre-selected white pine trees, using only the natural attractant produced by the female beetles feeding in fresh phloem.

2. A workable field method to accomplish 1, above, has been developed.

3. One attractive compound has been isolated, synthesized, and tested in the field. A second candidate compound is now in process.

4. Effective equipment and techniques for field bioassay have been developed.

5. Much has been learned about the daily and seasonal flight behavior of the mountain pine beetle as influenced by temperature, humidity, and other weather factors.

Plans

The Montana-Northern Idaho Forest Pest Acion Council has approved our Committee's recommendation to continue this research effort, and the North Idaho Forestry Association gave its endorsement at the November 2nd meeting. Plans for 1968 are to:

1. Attempt to develop more effective synthesized attractant compounds.

2. Test these compounds in the field.

3. Develop a field technique for using the synthesized attractants in an attempt to achieve some degree of effective control of beetle populations.

4. Refine field methods of utilizing the natural attractant in manipulating flying beetle populations.

5. Seek broader financial support for the 1968 project. The total required will be about $114,000; of this about $77,000 has been offered by Boyce Thompson Institute and other sources as last year, leaving a balance of $37,000 needed from local support. Potlatch Forests, Inc., has budgeted

$12,000 for the project in 1968 (as compared to $15,000 in 1967). Our Committee is hopeful the remaining $25,000 can be obtained from the Idaho cooperative pest abatement fund, and other sources if necessary. Contributions will be welcomed from other private forest land owners, forest industrial associations, and state or federal agencies.

This effort to broaden the financial support is justified by the facts that the mountain pine beetle is causing serious losses in public as well as private timber, it is attacking several commercially-important tree species, and it is widespread in many of the 11 western states.

Even though our present data indicate the level of the 1967 attack of mountain pine beetle to be somewhat lower than in 1966, severe tree mortality did continue. At this time not enough surveys have been made to predict the attack level for 1968, but we do know there are enough beetles to continue the epidemic under favorable weather conditions.

Furthermore, the 50-year recorded history of this insect proves it is periodically one of our most serious western pine killers. The timber values at stake fully warrant an aggressive research effort.

Our cooperative project has brought together some of the world's foremost scientists in a highly-coordinated team effort. We do not know of any comparable research on the mountain pine beetle by other private or public agencies; in view of this, we will continue to pursue the present course of action. We will welcome ideas and help from any interested source.

Hopefully presented,

Royce G. Cox, Chairman

Table 1

Summary of Data

MOUNTAIN PINE BEETLE

ATTRACTION PLOT

Silver Creek, Summer, 1966

Treat-* ment	Total No. of Trees	No. of Trees by Degree of Attack**				Total Trees Atkd. / Trtmt.	
		Mass	Mod.	Few	None	No.	%
N	21	6	0	5	10	11	52
GS	5	1	0	3	1	4	80
GSB	14	5	2	6	1	13	93
SB	2	1	0	1	0	2	100
B	3	0	0	2	1	2	67
Total	45	13	2	17	13	32	71
%	100	29	4	38	29	71	
Subtotal Treated	24	7	2	12	3	21	87
%	100	29	8	50	13	87	

*N = None; GS = Girdled & sprayed; GSB = Girdled, sprayed & baited; SB = Sprayed & baited; B = Baited only.

**Mass 100+
Moderate 20-100
Few 1-20

Table 2

Summary of Data

MOUNTAIN PINE BEETLE

ATTRACTION PLOT

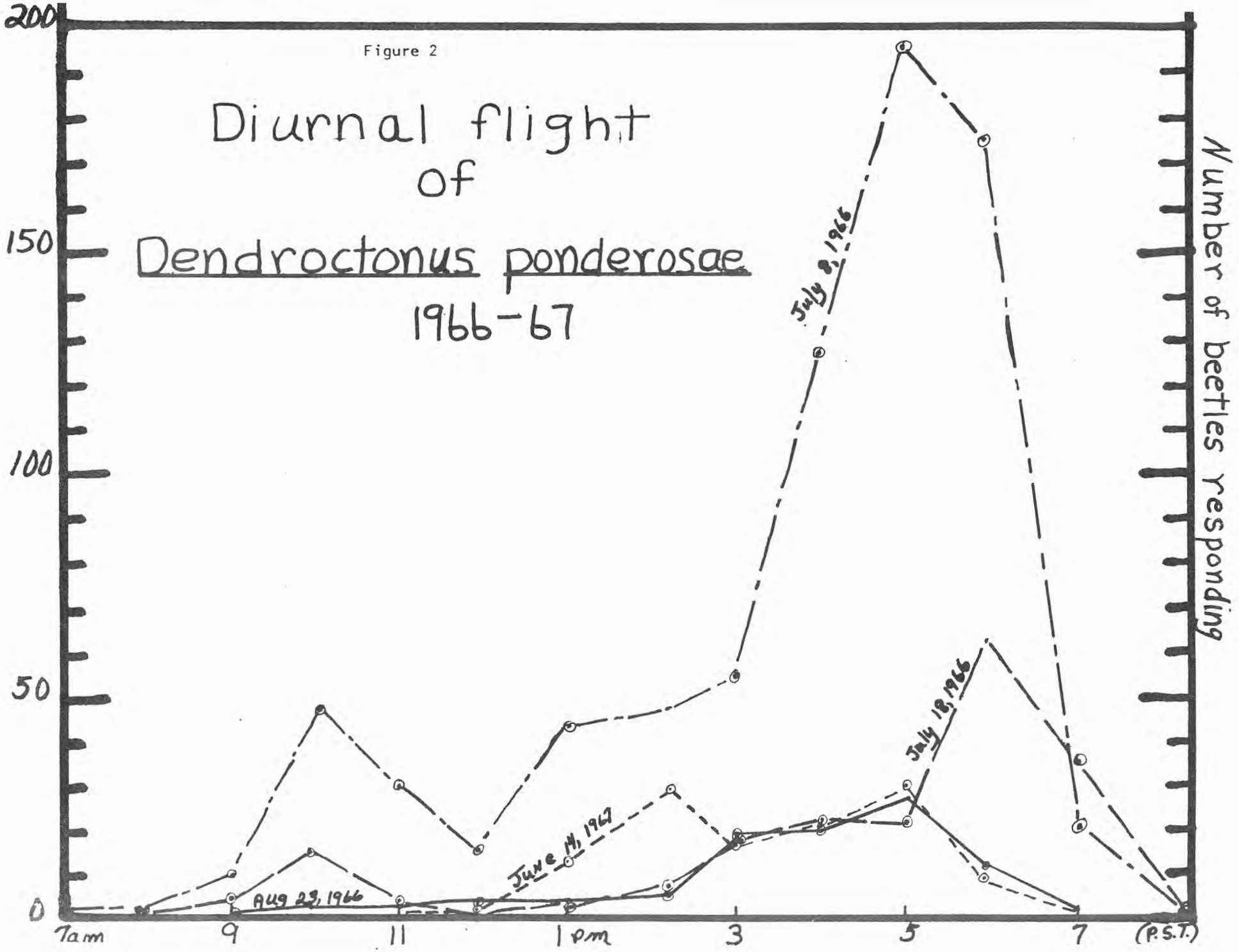
Reeds Creek, Summer, 1967

Treatment	Total No. of Trees	No. of Trees by Degree of Attack*				Total Trees Atkd./Treatmt.	
		Mass	Mod.	Few	None	No.	%
None	32	2	0	4	26	6	19
Cacodylic Acid	12	3	1	8	0	12	100
2,4-D, 2,4,5-T	11	0	2	8	1	10	91
Total	55	5	3	20	27	28	51
%	100	9	6	36	49	51	
Subtotal Treated	23	3	3	16	1	22	96
%	100	13	13	70	4	96	

*Mass 100+
Moderate 20-100
Few 1-20

Fig. 1. Dr. Schonherr loading field olfactometer with female infested billet.

Figure 2


Diurnal flight
of
Dendroctonus ponderosae
1966-67
200
150
100
50
0
7am
9
11
1pm
3
5
7
(P.S.T.)
Number of beetles responding
July 8, 1966
July 18, 1966
June 14, 1967
Aug 23, 1966

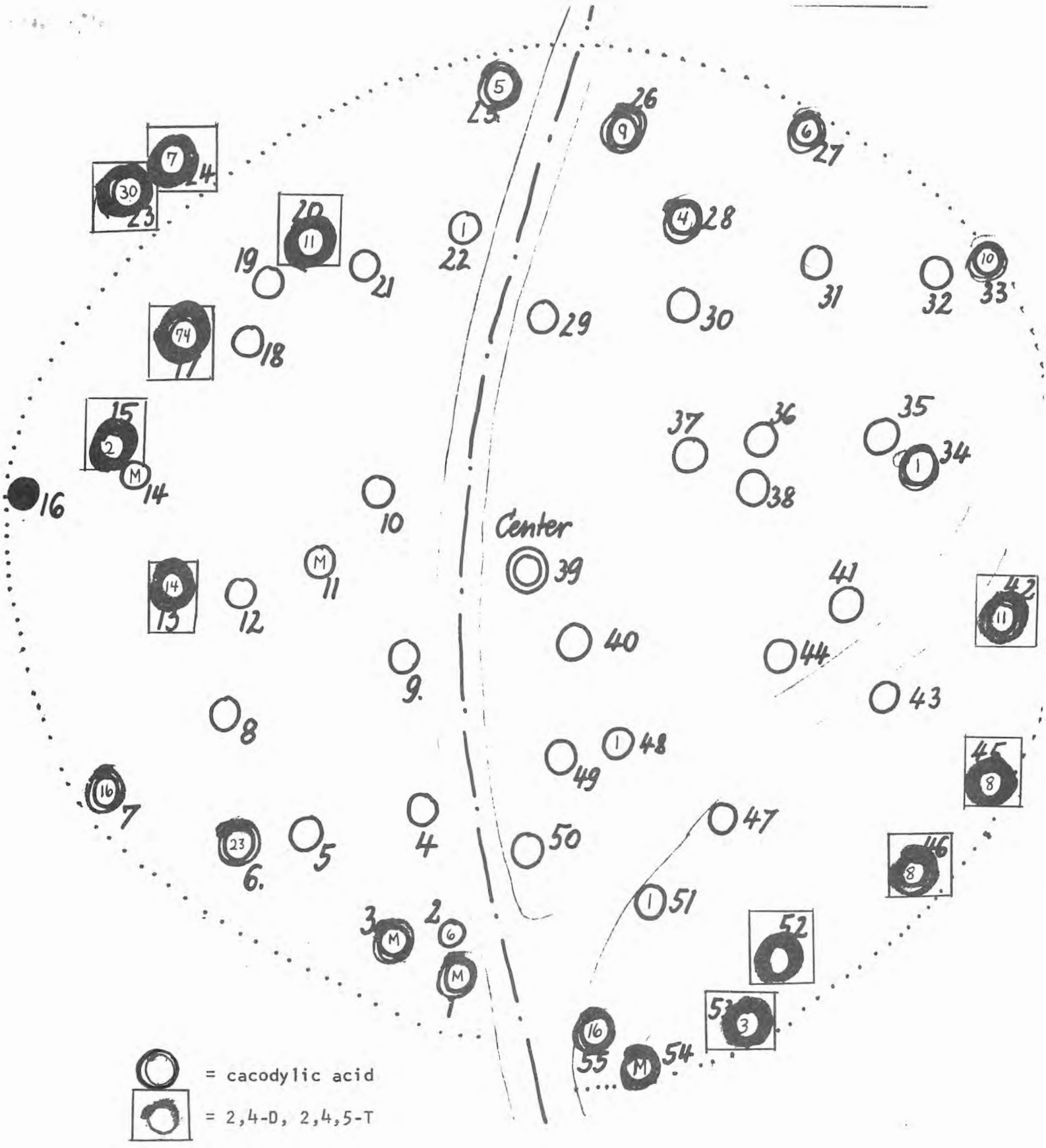


Figure 3

Attraction Plot, Reeds Creek
Summer, 1967

Fig. 4. Miss Tippets dissecting hindguts of female mountain pine beetles.